Arthroscopic Anatomic Coracoclavicular Ligament Repair Using a 6-Strand Polyester Suture Tape and Cortical Button Construct

MAJ Todd P. Balog, M.D., CPT (p) Kyong S. Min, M.D., CPT Jacob C. L. Rumley, D.O., CPT (p) David J. Wilson, M.D., and COL (ret) Edward D. Arrington, M.D.

Abstract: Acromioclavicular separations are common injuries. Low-grade separations are typically managed with nonoperative treatment. However, surgical treatment is recommended for high-grade separations, as well as for chronic low-grade separations that remain symptomatic. Multiple fixation techniques have been described over the past several decades, including Kirschner wires, hook plates, and coracoclavicular screws. More recently, a single-tunnel suture-graft repair and an anatomic reconstruction reproducing both the conoid and trapezoid ligaments have been described. All described techniques have reported complications, including implant migration, need for implant removal, clavicle or coracoid fracture, and loss of reduction. As a result, there is no single optimal method of operative fixation. We describe our technique for an arthroscopically assisted anatomic coracoclavicular repair using a 6-strand suture tape and cortical button construct.

Acromioclavicular (AC) separations account for 12% of all traumatic shoulder girdle injuries. According to Rockwood's classification system, nonoperative treatment is recommended for grades I and II and operative treatment for grades IV through VI. Management of grade III separations remains controversial.[1] Multiple operative techniques for these injuries have been described. More historical methods of fixation include Kirschner wires, hook plates, and use of a coracoclavicular screw. Complications related to these methods include implant migration, loss of reduction, and need for implant removal. More recently, single-tunnel and anatomic double-tunnel repairs with either graft or suture fixation have been described. Despite these advances, complications such as clavicular fracture, coracoid fracture, and loss of reduction have been reported.[2-4] The optimal method of fixation would provide for anatomic repair or reconstruction of both ligaments, minimize the number and diameter of clavicle and coracoid tunnels, and provide sufficient strength to maintain reduction until the native ligaments have healed. We describe our technique for arthroscopically assisted anatomic coracoclavicular ligament repair of acute high-grade AC separations using a 6-strand suture tape and cortical button construct.

From Blanchfield Army Community Hospital (T.P.B.), Fort Campbell, Kentucky, U.S.A.; Brian Allgood Army Community Hospital (K.S.M.), Seoul, Republic of Korea; and Madigan Army Medical Center (J.C.L.R., D.J.W., E.D.A.), Tacoma, Washington, U.S.A.

The authors report the following potential conflict of interest or source of funding: J.C.L.R., D.J.W., and E.D.A. receive general institutional research support from The Geneva Foundation and Henry M. Jackson Foundation for the Advancement of Military Medicine.

Received March 19, 2015; accepted July 28, 2015.

Address correspondence to MAJ Todd P. Balog, M.D., 129 Bainbridge Dr, Clarksville, TN 37043, U.S.A. E-mail: tbalog99@gmail.com

Published by Elsevier Inc. on behalf of the Arthroscopy Association of North America

2212-6287/15262/$36.00

http://dx.doi.org/10.1016/j.eats.2015.07.023

Surgical Technique

The patient is placed in the beach-chair position, and a large C-arm is positioned from the contralateral side (Fig 1). The implants required for this procedure include 1 long FiberTape (Arthrex, Naples, FL), 1 standard-length TigerTape (Arthrex), and 3 Dog Bone Buttons (Arthrex).

We begin with diagnostic arthroscopy. The anterior portal is created in a more lateral position for a direct approach to the subcoracoid space. This portal is usually just distal to the anterolateral edge of the acromion (Table 1). An electrocautery wand (ArthroCare, Austin, TX) is used to open the rotator interval and expose the undersurface of the coracoid (Video 1). The medial and lateral borders and the "knee" of the coracoid must be

Fig 1. Patient setup in the beach-chair position with fluoroscopy brought in from the contralateral side to assist with tunnel creation and visualization of the reduction.

exposed to facilitate careful placement of the single coracoid tunnel.

A direct approach to the clavicle is then performed. A vertical or transverse incision can be used to expose the superior clavicle, where 2 tunnels will be created. We begin with the medial (conoid) tunnel. This tunnel should be placed at less than 25% of the length of the clavicle from the AC joint.[4] This location is determined from preoperative radiographs and is measured and marked with electrocautery. The coracoclavicular drill guide (Arthrex) is then inserted into the shoulder through the anterior portal (Fig 2A). It is centered on the undersurface of the coracoid and is positioned just anterior to the "knee." Superiorly, it is placed at the predetermined and marked medial tunnel location. Under fluoroscopy, a 3.0-mm cannulated guidewire is placed to create our medial and coracoid tunnels (Fig 2B). A 3.0-mm tunnel is the smallest tunnel able to pass 6 strands of suture tape. The drill guide is then removed. A Chia passing wire (DePuy Synthes, Warsaw, IN) is passed through the cannulated guidewire and pulled out the anterior portal. The cannulated guidewire is removed, and the patient is ready to undergo passage of the fixation construct.

Implant preparation is then performed. The TigerTape is threaded through the first Dog Bone Button until both limbs are equal in length (Fig 3A). The Dog Bone Button should be positioned with the black stripe toward the ground so that the concave aspect will be contoured to the undersurface of the coracoid. The long FiberTape is then threaded through the same Dog Bone Button until the short limb is equal in length to the TigerTape limbs (Fig 3B). The long limb of the FiberTape is passed through the loop of the Chia passing wire (Fig 4A) and is then threaded back through the Dog Bone Button (Fig 4B). The 2 limbs of the FiberTape should be passing through opposite ends of the Dog Bone Button.

The 2 limbs of the FiberTape and 2 limbs of the TigerTape are then looped through the Chia passing wire and are pulled up through the coracoid and out the medial clavicle tunnel. The Chia passing wire must be cut to release the loop of FiberTape. The limbs of the TigerTape and FiberTape and loop of the FiberTape are pulled individually until the Dog Bone Button lies flush on the undersurface of the coracoid (Fig 5).

The soft tissue overlying the anterior edge of the clavicle is then elevated, and a right angle is used to reach underneath the clavicle and grasp the TigerTape limbs. The TigerTape limbs are pulled out of the medial clavicle tunnel and left anterior to the clavicle.

The lateral (trapezoid) tunnel is then created with a 2.4-mm drill bit. We position this tunnel approximately 15 mm lateral to the conoid tunnel. A Hewston suture passer (Smith & Nephew Endoscopy, Andover, MA) is placed through the lateral tunnel, and the limbs of the TigerTape are pulled through the lateral tunnel.

The loop and the 2 limbs of the FiberTape are passed through a second Dog Bone Button. This creates a double pulley for the 4-strand conoid ligament repair. With the AC joint manually reduced, the limbs of the long FiberTape are toggled until the Dog Bone Button is flush on the clavicle. The limbs are then tied over the Dog Bone Button (Fig 6). The limbs of the TigerTape are

Table 1. Pearls, Pitfalls, and Complications

Pearls
The anterior portal should be established just distal to the anterolateral border of the acromion to facilitate coracoid exposure.
The suture-button construct should be introduced with a locking grasper to facilitate better control as the suture is being advanced through the tunnels.
A 70° arthroscope may be helpful for improved coracoid visualization and should be available.
Pitfalls
The clavicle-coracoid tunnel must be 3.0 mm to pass the suture construct.
The surgeon should ensure that the cannulated guidewire is centered on the coracoid and posterior to lessen the risk of fracture.
Implant preparation may be confusing the first time and can be performed in a laboratory or on a model before surgery.
Complications
We have experienced breakage of the Chia passing wire while attempting to pass the construct. In this instance a new Chia passing wire is passed and used to shuttle a FiberLink (Arthrex) for construct passage.

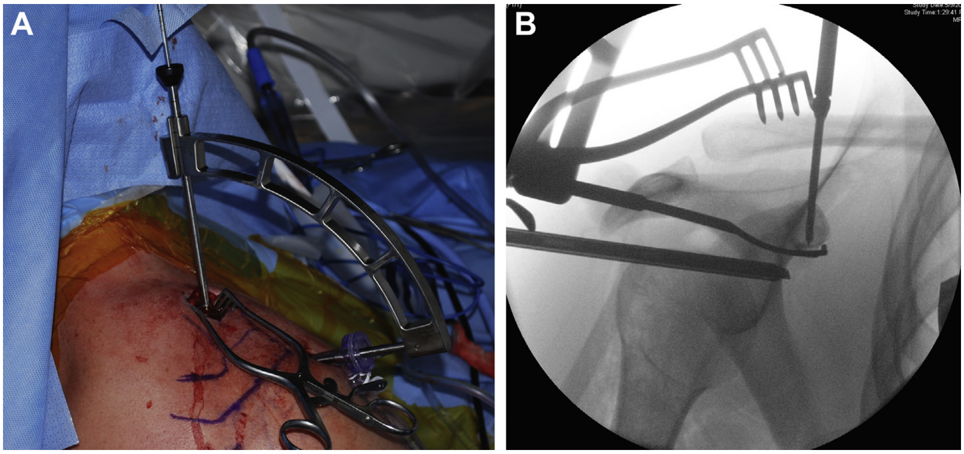
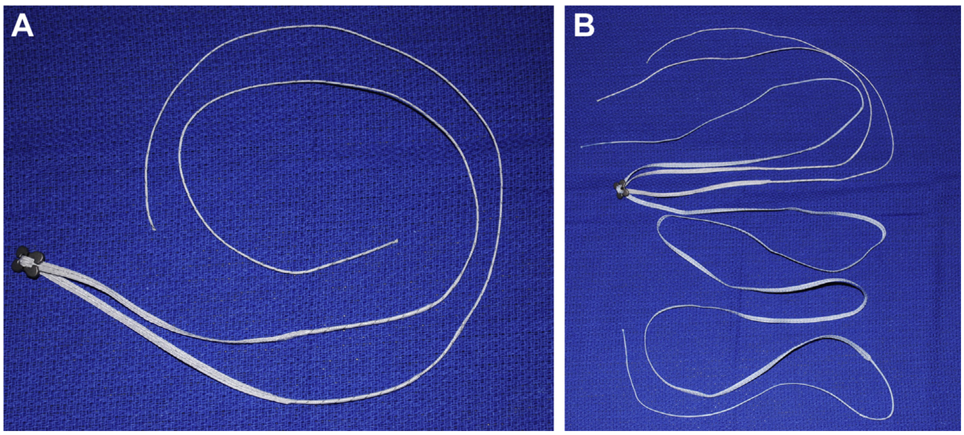


Fig 2. (A) Insertion of the coracoclavicular drill guide through the anterolateral portal. Care must be taken to ensure that it is centered underneath the coracoid. Superiorly, it is placed in the intended position for the medial (conoid) tunnel through a small transverse incision. (B) Fluoroscopic confirmation of appropriate positioning of the 3.0-mm cannulated guidewire for the medial (conoid) and coracoid tunnels. One should note that the tunnel is centered in the coracoid to reduce the possibility of a fracture.

Fig 3. (A) In step 1 of the suture construct assembly, the TigerTape is threaded through the Dog Bone Button, ensuring that both limbs are equal in length. (B) In step 2, the long FiberTape is threaded through the Dog Bone Button until the short limb is equal in length to the 2 TigerTape limbs.



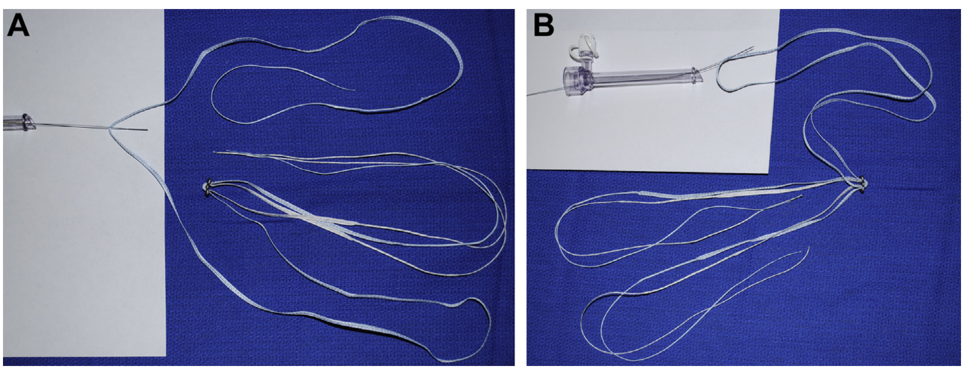


Fig 4. (A) In step 1 of the suture construct passage, the long limb of the FiberTape is passed through the Chia passing wire, which was passed through the cannulated guidewire and pulled out the anterolateral portal. (B) In step 2, the long limb of the FiberTape is then threaded back through the Dog Bone Button in the opposite direction of the previously threaded short limb. The 4 free limbs are then looped through the Chia passing wire, and the suture tape construct is ready to be passed through the tunnels.

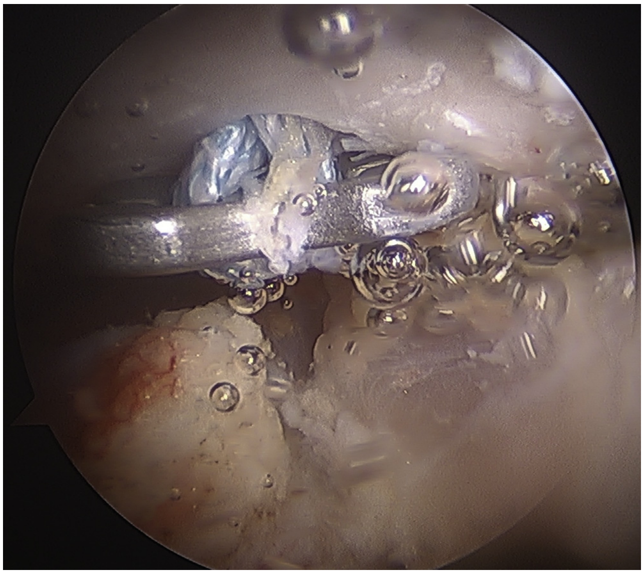


Fig 5. Arthroscopic visualization of the final seating of the first Dog Bone Button underneath the coracoid.

threaded through a third Dog Bone Button. While reduction is maintained, the TigerTape is tied over the Dog Bone Button. This creates a 2-strand repair of the trapezoid ligament (Fig 7). The coracoclavicular ligament repair is now complete with a total of 6 strands: 4 strands with a double pulley for the conoid tunnel and 2 strands for the trapezoid tunnel. The final radiographic appearance is shown in Figure 8A.

Fig 6. Fluoroscopic confirmation of reduction with the second Dog Bone Button over the medial (conoid) tunnel, securing the 4-strand conoid repair.

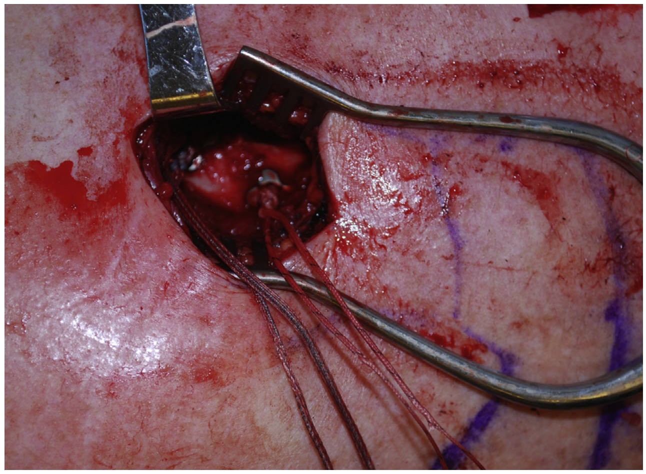


Fig 7. Visualization of Dog Bone Button fixation of both the conoid and trapezoid repairs on the superior aspect of the clavicle.

The patient is immobilized in a sling for 6 weeks and then begins gentle range of motion. A 3-month follow-up radiograph is shown in Figure 8B with maintenance of reduction.

Discussion

Historical methods of AC joint fixation with Kirschner wires, hook plates, and coracoclavicular screws have resulted in a high rate of complications including wire migration or breakage in 41% of patients, migration or breakage of coracoclavicular screws in 12%, and loss of reduction in 3.1% to 13.2%.[1] In addition, all of these implants require removal. The more recent trend toward tunnel and suture-graft fixation appears promising, but direct comparison of different techniques is difficult because multiple variables exist, including the use of 1 versus 2 tunnels, graft versus suture, allograft versus autograft, and adjustable-length suture versus nonadjustable suture. Recent reports have questioned the effectiveness of single-tunnel constructs. Cook et al.[5] reported an 80% loss of reduction in single-tunnel reconstruction using a combination of No. 5 nonabsorbable suture and an incorporated allograft. Shin and Kim[6] reported a 33% rate of loss of reduction of more than 50% in 18 patients managed with a single-tunnel, adjustable-loop suspensory device. They also reported a 44% complication rate, including 3 instances of fixation failure and 3 instances of clavicular erosion by the superior suspensory button. Grassbaugh et al.[3] showed a higher percentage of a final radiographic type I appearance among 2-tunnel constructs versus either single-tunnel, adjustable-length suture or single-tunnel, nonadjustable suture with graft. From these studies, it appears that a 2-tunnel construct may maintain reduction more reliably.

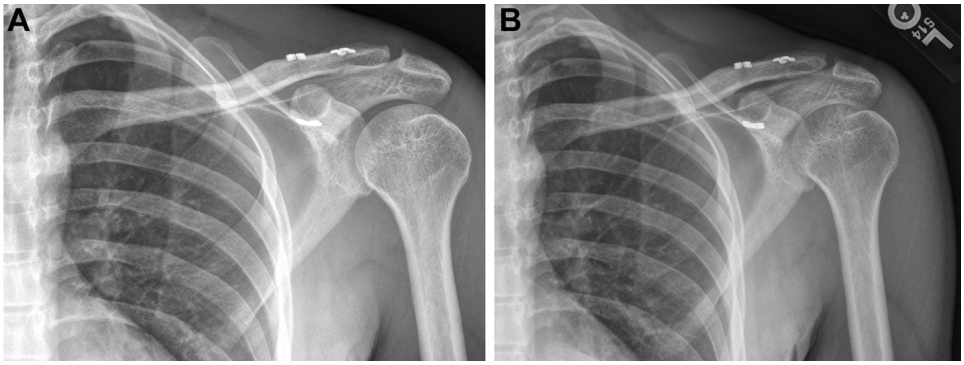


Fig 8. (A) Immediate postoperative anteroposterior radiograph of a left shoulder showing the final construct. (B) Three-month follow-up anteroposterior radiograph of the same left shoulder showing maintenance of reduction.

A 2-tunnel anatomic repair with use of adjustable-length suture has been described. Scheibel et al.[7] reviewed 28 patients with acute type V separations treated with 2 independent adjustable-length sutures. Their technique required 2 independent 4.0-mm coracoid tunnels. They reported good to excellent clinical results at 2 years' follow-up but some mild loss of reduction between 3 and 6 months. The disadvantages of this technique include the 2 larger-diameter coracoid tunnels and mild loss of reduction, which could potentially be due to loosening of adjustable-length sutures. However, the clinical results of Scheibel et al. were all good to excellent, and a cadaveric biomechanical study of this construct showed it to be as strong as or stronger than the native ligaments.[8]

The advantages of our technique include a 6-strand anatomic repair using ultra-strength suture tape along with minimal-diameter clavicular tunnels and only a single coracoid tunnel (Table 2). A recent biomechanical study has shown that 2.4-mm clavicle tunnels have minimal effect on clavicular strength compared with its native strength.[9] Although we describe this technique for use in the acute setting, we have also used it in the subacute setting with the addition of a looped graft. In conclusion, this technique resembles a previously reported technique with the advantages of ultra-strength suture tape, smaller clavicular tunnels, and a single coracoid tunnel.

Table 2. Advantages and Limitations of 6-Strand Polyester Suture Tape and Cortical Button Construct

Advantages
Smaller clavicular drill tunnels
Single smaller-diameter coracoid drill tunnel
Smaller surgical incisions
Theoretically lower coracoid fracture risk
6 high-strength suture strands
Limitations
No collagen graft
Technique for acute repairs only
Clavicle fracture risk

Acknowledgment

The authors acknowledge Mr. Kelly Lewis for his assistance and insight into developing the described technique.

References

1. Modi CS, Beazley J, Zywiel MG, Lawrence TM, Veillette CJH. Controversies relating to the management of acromioclavicular joint dislocations. *Bone Joint J* 2013;95-B:1595-1602.
2. Milewski MD, Tompkins M, Giugale JM, Carson EW, Miller MD, Diduch DR. Complications related to the anatomic reconstruction of the coracoclavicular ligaments. *Am J Sports Med* 2012;40:1628-1633.
3. Grassbaugh JA, Cole C, Wohlrab K, Eichinger J. Surgical technique affects outcomes in acromioclavicular reconstruction. *J Surg Orthop Adv* 2013;22:71-76.
4. Cook JB, Shaha JS, Rowles DJ, Bottoni CR, Shaha SH, Tokish JM. Clavicular bone tunnel malposition leads to early failures in coracoclavicular ligament reconstructions. *Am J Sports Med* 2013;41:142-149.
5. Cook JB, Shaha JS, Rowles DJ, Bottoni CR, Shaha SH, Tokish JM. Early failures with single clavicular transosseous coracoclavicular ligament reconstruction. *J Shoulder Elbow Surg* 2012;21:1746-1752.
6. Shin SJ, Kim NK. Complications after arthroscopic coracoclavicular reconstruction using a single adjustable loop length suspensory fixation device in acute acromioclavicular joint dislocation. *Arthroscopy* 2015;31:816-824.
7. Scheibel M, Dorschel S, Gerhardt C, Kraus N. Arthroscopically assisted stabilization of acute high-grade acromioclavicular joint separations. *Am J Sports Med* 2011;39:1507-1515.
8. Walz L, Salzmann GM, Fabbro T, Eichborn S, Imhoff AB. The anatomic reconstruction of acromioclavicular joint dislocations using 2 Tightrope devices. *Am J Sports Med* 2008;36:2398-2406.
9. Spiegl UJ, Smith SD, Euler SA, Dornan GJ, Millett PJ, Wijdicks CA. Biomechanical consequences of coracoclavicular reconstruction techniques on clavicle strength. *Am J Sports Med* 2014;42:1724-1730.